

Sea Surface Temperature

Q: What are the trends in the critical physical and chemical attributes of the Nation's ecological systems?

The above question pertains to all 'Critical Physical and Chemical Attributes' Indicators, however, the information on these pages (overview, graphics, references and metadata) relates specifically to "Sea Surface Temperature". Use the right side drop list to view the other related indicators on this question.

Introduction

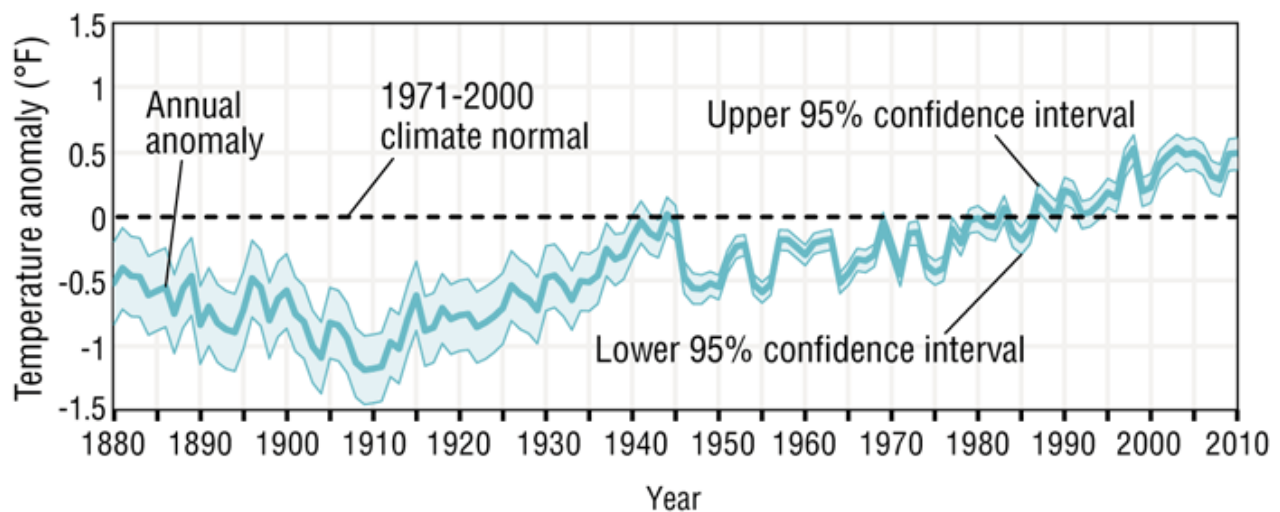
Sea surface temperature (SST) is a critical physical attribute of oceans and coastal ecological systems. Water temperature directly affects biological and physical process rates, water column stability, and the presence and functioning of species of plants (e.g., algae, sea grasses, marsh plants, mangroves) and animals (e.g., microscopic animals, larger invertebrates, fish, mammals). Increases in temperature have been associated with the timing of breeding in sea turtles (Weishampel et al., 2004), stress and bleaching of coral reefs (Brown, 1997; Woodbridge and Done, 2004), alteration of species migration patterns, changes in ecological system extent and composition (Helmuth et al., 2002), and changes in the frequency or extent of blooms of harmful algae (Ostrander et al., 2000). On longer time scales (decades to centuries), rising SST may result in decreases in the supply of nutrients to surface waters from the deep sea, which may trigger a cascade of effects leading to decreases in primary production and declines in fish production (Pratchett et al., 2004), wetland loss, reductions in coastal storm buffering, and losses of local tourism. Tropical storms and hurricanes gain strength over warm ocean waters, and the power and frequency of Atlantic hurricanes have increased substantially in recent decades (Kunkel et al., 2008). Observed evidence indicates a relationship between sea surface temperatures and hurricane power in the North Atlantic Ocean (Emanuel, 2007). Thus, SST is both an indicator of and an influencing factor on climate conditions and variability. Changes in SST may result from long-term cycles in ocean circulation, climate variability, or secular trends in climate (Committee on the Bering Sea Ecosystem et al., 1996).

This SST indicator, developed by the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA) and the National Center for Atmospheric Research, describes the long-term variability and change in global mean SST for the 1880–2010 period. This reconstruction provides consistent spatial and temporal data with their associated 95 percent confidence intervals. The data are compiled from in situ measurements from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) release 2 (Slutz et al., 2002). Data are available from multiple sources (e.g., ship reports, buoy monitors, oceanographic profiles) from as early as 1854 (Woodruff et al., 1998). By filtering and blending datasets that use alternative measurement methods and include redundancies in space and time, this reconstruction is able to fill spatial and temporal data gaps and correct for biases in the different measurement techniques (e.g., uninsulated buckets, intakes near warm engines, uneven spatial coverage). The extended reconstructed data are shown as anomalies, or differences, from the “normal” (i.e., average) SST from 1971 to 2000. The long-term average change obtained by this method is very similar to those of “unanalyzed” measurements and reconstructions developed by other researchers (e.g., Rayner et al., 2003).

What The Data Show

The reconstruction of SST anomalies over all latitudes indicates that the highest SSTs during the period of record (1880–2010) occurred over the last three decades (Exhibit 6-19). Warming has occurred through most of the twentieth century and appears to be independent of measured inter-decadal and short-term variability (Smith and Reynolds, 2005). The SST warming generally occurred in two parts, the first between 1910 and 1940 and the second beginning in the mid-1970s, with a roughly stationary period in between. SST appears to have cooled between 1880 and 1910, although confidence intervals are wider over the early period of record. Despite that uncertainty, warming for the entire period of the indicator and for the period from 1900 forward is statistically significant.

Exhibit 6-19. Annual global sea surface temperature anomaly, 1880-2010^a



^a **Coverage:** Anomaly with respect to the 1971-2000 climate normal, which is plotted as zero.

Data source: NOAA, 2011

Limitations

- The 95 percent confidence interval is wider than other methods for long-term reconstructions; in mean SSTs, this interval tends to damp anomalies.
- The geographic resolution is too coarse for ecosystem analyses but reflects long-term and global changes as well as shorter-term variability.
- The reconstruction methods used to create this indicator remove most random “noise” in the data. However, the anomalies are also damped when and where data are too sparse for a reliable reconstruction. The 95 percent confidence interval reflects this “damping” effect and uncertainty caused by possible biases in the observations.

- Data screening results in loss of multiple observations at latitudes higher than 60 degrees north or south. Effects of screening at high latitudes are minimal in the context of the global average; the main effect is to lessen anomalies and widen confidence intervals.

Data Sources

This extended reconstruction of SST, called ERSST.v3b, was described in Smith et al. (2008). NCDC (NOAA, 2011) provides access to monthly and annual SST error data from this reconstruction (<http://www.ncdc.noaa.gov/ersst/>), and a mapping utility that allows the user to calculate average anomalies over time and space (<http://nomads.ncdc.noaa.gov/#climatencdc>). The ERSST.v3b reconstruction is based on in situ measurements, which are available from online databases—for example, NOAA (2010) (<http://icoads.noaa.gov/products.html>).

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